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ADAPTING MONITORING PROTOCOLS AND STRATEGIES FOR THE GILBERT BAY MARINE PROTECTED AREA

Golden cod. Photo by: Corey Morris

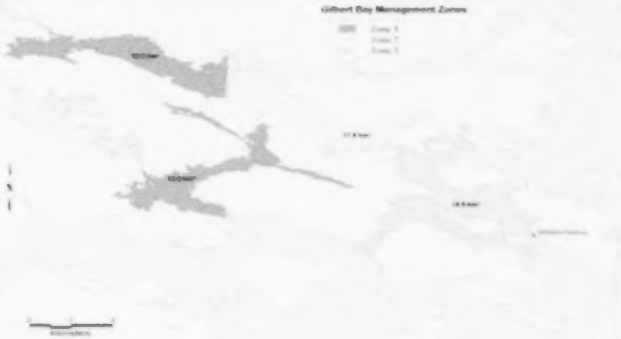

Figure 1: Gilbert Bay Marine Protected Area.

Context:

The Gilbert Bay Marine Protected Area (MPA) was established in 2005 with the conservation objective of protecting and conserving a unique population of Atlantic Cod (Gadus morhua) and its habitat. The monitoring framework developed for Gilbert Bay is based upon the conservation objective, against specific threats to the unique cod population. The Atlantic Cod population in Gilbert Bay (hereafter referred to as Gilbert Bay cod) has been monitored since 1998 (Morris and Green 2010), and the MPA monitoring program was reviewed in 2009. As a result, several indicators, protocols, and strategies were adopted as the Gilbert Bay MPA scientific monitoring program (DFO 2010).

A Regional Peer Review process for the Gilbert Bay MPA was held December 8, 2016, in St. John's, Newfoundland and Labrador (NL). The purpose was to review the existing monitoring program and consider potential changes to the existing long-term monitoring program. Scientific monitoring suggests that the Gilbert Bay cod population has declined. Concerns for the population's health have raised important questions regarding future research, mitigation, and options for improved management.

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Canada

SUMMARY

- Gilbert Bay's *Oceans Act* MPA monitoring program includes 19-years of data and is among the longest in Canada. The Gilbert Bay MPA was established in 2005 with the conservation objective of protecting and conserving the unique population of Atlantic Cod and its habitat.
- The Gilbert Bay cod population has declined and remained at a low level of abundance since it was last assessed in 2010, with catch rates of commercial sized fish at, or less than, 10% of what they were at the beginning of the monitoring period in 1998.
- Long-term monitoring has indicated the recent appearance of sculpins, Rock Cod (*Gadus ogac)* and flounders which are competitors or predators of Gilbert Bay cod.
- Harvesting of cod directly impacted the Gilbert Bay cod population in 1998/99. With the population decline of Gilbert Bay cod, particularly since 2007, impact from fisheries outside of the MPA and within the home range of Gilbert Bay cod may be significant.
- Timing, location, or harvesting methods of Northern cod in areas outside the MPA, but within the home range of Gilbert Bay cod, could be adapted to reduce impacts on the Gilbert Bay cod population.
- Gilbert Bay cod are often more brown in colour than Northern cod, which can often be used to distinguish them. Live trapping or potting, which enables the live-return of cod, could allow Gilbert Bay cod to be released as a conservation measure.
- Genome-wide genetic analysis indicates strong population differentiation between Gilbert Bay cod and offshore Northern cod. This provides evidence that there is potential for local adaptation.
- Existing indicators are sufficient to monitor the population. Standardized plankton tows and research angling should continue annually to ensure the integrity of the monitoring program. Existing monitoring methods should not be replaced by additional monitoring methods.
- Existing movement and migration monitoring methods continue to be important to assess threats and improve management advice for the Gilbert Bay cod population.

BACKGROUND

Establishment of the Gilbert Bay MPA

Gilbert Bay is a narrow inlet located on the southeast coast of Labrador approximately 300 km from Happy Valley-Goose Bay. Gilbert Bay was designated as a MPA under the *Oceans* Act on October 11, 2005. The primary regulatory based conservation objective for the Gilbert Bay MPA is ***the conservation and protection of the Gilbert Bay cod and its habitats***. The MPA regulatory conservation objectives are part of site specific regulations (Canada Gazette 2005). In 2007, the Gilbert Bay MPA Management Plan was released. It outlines conservation objectives and management actions for the MPA with respect to scientific monitoring, compliance and enforcement, as well as public awareness with the intent to guide and inform management decisions. This Management Plan was renewed in 2010. The monitoring program supporting the Management Plan helps determine whether the MPA is successful in meeting the conservation objectives.

The Gilbert Bay *Oceans Act* MPA has one of the longest continuous science monitoring programs in Canada. Data have been gathered for the Gilbert Bay cod monitoring program

since 1996, and the program has been conducted consistently since 1998. The area became a MPA in 2005 and since then there have been two management plans. The Gilbert Bay MPA monitoring program was reviewed in 2009. As a result, several indicators, protocols, and strategies were identified and adapted as part of the ongoing monitoring program (Morris and Green 2010). This is important to:

1. Enable incorporation into broader MPA monitoring plans;
2. Track whether the MPA is effective in achieving conservation objectives; and
3. Aid managers in the adjustment of MPA management plans to achieve conservation objectives.

The monitoring program has effectively tracked the cod population's status based on several indicators, and the 20-year time series has identified population trends that are important for management.

This report provides an updated overview of the Gilbert Bay cod monitoring program, considering the potential to improve monitoring efficiency. The Gilbert Bay cod population has been and currently remains at a very low level of abundance, based on existing data in the monitoring time series. Adaptive management could potentially reduce impacts on the population. However, it is important to consider effects of adaptive management changes prior to implementing them, especially if changes to long-term monitoring indicators could occur. The purpose of this assessment includes a review of existing indicator data describing changes in the Gilbert Bay cod population. The relative importance of existing indicators and any need for additional research or indicators is also considered. Based on this, a summary of the status of the Gilbert Bay cod population is provided, along with potential changes (or lack thereof) to the established monitoring program.

Threats to the population

The Gilbert Bay MPA was established in response to concerns that fishing threatened the local cod population. In 1998, immediately after the Northern cod moratorium, fishing effort was concentrated in Gilbert Bay which prompted community support to protect the local cod population from overfishing (Morris et al. 2002). At that time the abundance of cod in Gilbert Bay was high compared to other areas. Knowing that the population is small and removals by fishing are relatively large, fishing is considered to be the primary factor affecting the population (Morris and Green 2014). Gilbert Bay cod are known to leave the MPA during summer (Morris et al. 2014). Northern cod fishing effort and removals have been increasing in recent years, in response to improvements in the status of Northern cod. Fishery removals of cod in the vicinity of Gilbert Bay during 2016 were at the highest level since 1998. The 2016 season was also the longest fishing season since the Northern cod moratorium. Harvesting Northern cod in the vicinity of Gilbert Bay could impact Gilbert Bay cod recovery.

As the Gilbert Bay cod population declined in abundance, the fish community within Gilbert Bay also changed. Other species of fish that were not previously observed during monitoring prior to 2008 have been continually observed since 2009. The impact of changes in the fish community is not well understood. However, information from other MPA studies indicates that predation effects have the ability to control the abundance of conspecifics (Edgar and Stuart-Smith 2009).

ASSESSMENT

Throughout the MPA monitoring period (1998-present), five indicators of population change and potential human induced threats have been monitored:

1. Recruitment of age 0 pelagic juveniles;
2. Recruitment of ages 2, 3, 4 Atlantic Cod;
3. Research Catch per Unit Effort (CPUE);
4. Movement and migration patterns; and
5. Catch information from commercial fishing.

Recruitment of age 0 pelagic juveniles

This indicator can be used to demonstrate recruitment. However, a strong link between age 0 abundance and population trends in abundance has not been demonstrated. At age 0, sampling includes two life history stages; the egg stage and the pelagic juvenile stage.

The egg stage is sampled in early-June at a spawning location. The abundance of eggs in the water column has been generally high (~ 50 eggs per m^3), but variable. In 2016, an extremely low density of cod eggs were sampled (~1 cod egg per m^3) which has not previously been observed. Although egg density has not been an accurate indicator of year class abundances, its value towards monitoring evidence of reproductive output has increased, based on results from 2016. This indicator is now considered an important indicator of population persistence.

The pelagic juvenile stage is sampled yearly in early-August at the same location as egg sampling. The abundance of pelagic juveniles has been variable but information has been considered useful as a general indication of strong or weak year classes in the past. However, in 2008, Rock Cod (*G. ogac*) were observed for the first time during regular angling and have continued to be caught each year since then. At the pelagic juvenile stage (when fish are between 15 mm and 30 mm total length) it is very difficult to distinguish between the Rock Cod and Atlantic Cod (*G. morhua*) based on visual characteristics. In recent years, some of the larger pelagic juveniles were identified visually as Rock Cod, which was later supported by genetic analysis, and further taxonomic work is needed to ensure that this indicator provides valuable information. Future monitoring should distinguish between *G. ogac* and *G. morhua* to monitor potential increase in *G. ogac*, as well as the strength of Gilbert Bay cod year classes.

Recruitment of ages 2, 3, 4 Atlantic Cod

This indicator is used to demonstrate periods of poor recruitment. It is based on angling information, but focuses on the relative abundance of fish that are generally less than 30 cm in total length. At sizes less than 30 cm it is possible to distinguish modes in length frequency distributions that correspond to year classes. The typical size range of a year class was compared with the ages of fish based on otolith sampling before 2008. Otoliths have not been collected for several recent years because it requires lethal sampling, which has been avoided because of the continued decline and low abundance of Gilbert Bay cod.

Research CPUE

This indicator is used as an index of abundance for Gilbert Bay cod. The catch of fish is also divided by size, including fish that have reached commercial or reproductive sizes. This provides a fishery-related or biological reference for management considerations. Research

CPUE sampling is considered a reasonable indicator regarding the health and relative status of the Gilbert Bay cod population, including abundance, size distribution, and composition of the general fish community.

The CPUE data has indicated a decline in the abundance of Gilbert Bay cod. The catch rate of fish was approximately six fish per hour of fishing in 1998 and declined as low as 0.5 fish per hour in 2014. The CPUE was about one fish per hour in 2016. The number of fish larger than 45 cm, which is approximately the size at which most fish are recruited to the commercial fishery, has declined from approximately 375 fish sampled in 1998, to less than 25 fish sampled during each of the past three years of sampling, with the same level of fishing effort. Other standardizations used to maintain consistency of sampling include visiting approximately the same 20 fishing locations each year, sampling at the same time of year (June 1-10), and using the same methods.

Catch data have also indicated changes in the fish community. From 1998 until 2008, only Atlantic Cod were caught in the MPA zone 1A. Since 2008, annual sampling has caught other species in addition to Atlantic Cod, including Rock Cod, flounder, and sculpin. Measuring the occurrence of these species has become an increasingly important part of the existing monitoring program.

Movement and migration patterns

This indicator has been based on tagging of Gilbert Bay cod, which has included external tagging and acoustic telemetry tracking of electronically tagged fish. This indicator has not provided a constant source of monitoring information. Tagging experiments (and acoustic telemetry) are conducted sporadically, while the tagging rate, recovery rate, and reporting rate have changed considerably over time. In most recent years, a low number of fish have been tagged with external tags because few fish are large enough to tag, and few tagged fish are recaptured and returned from commercial fishing. External and acoustic tags remain an important research tool to address potential factors impacting the population. Acoustic tags provide fishery-independent information, and are particularly important for providing information about fish movements throughout the year. Research includes the identification of stock mixing, mortality, and migration patterns of both Gilbert Bay and Northern cod. Tagging will also be an important part of adapting new monitoring methods, such as pot fishing to measure its success, and could be included as part of new monitoring techniques.

Catch information from commercial fishing

This indicator is based primarily on commercial catch data recorded by Fisheries and Oceans Canada (DFO). It has included the total reported landings from several harvesters that fish commercially within the range of Gilbert Bay cod.

In 2016, the Northern cod fishing season and the total catch has been the longest and largest removal of Atlantic Cod since the Northern cod moratorium.

Sources of Uncertainty

There remains uncertainty about the number of Atlantic Cod removed by recreational, Aboriginal, and by-catch fishing in the vicinity of Gilbert Bay.

Environmental change has not been considered as a formal part of the assessment of Gilbert Bay cod. It is possible that elusive environmental change could be regulating population productivity, but no evidence has been observed to support this. A more in-depth analysis of

environmental conditions can be conducted to investigate environmental factors in greater detail. Environmental factors might include physical parameters, such as temperature or oxygen. Unknown trophic interactions could also affect the local cod population.

CONCLUSIONS AND ADVICE

Few changes are recommended to the Gilbert Bay cod monitoring program, in favor of continuing its consistency such that future changes can be compared with historical data. The five indicators currently used to monitor the Gilbert Bay cod population have been appropriate to monitor the MPA against its conservation objectives. This is one of the longest and consistent *Oceans Act* MPA monitoring programs in Canada, and the information is used to assist management decision making. Any new monitoring methods should add to, rather than replace, existing monitoring.

Since the last assessment of Gilbert Bay cod, the population has continued to decline (DFO 2010), and is currently at a relatively low level of abundance. Existing indicators have been utilized in combination, to strengthen the advice to MPA managers regarding the status of the protected population. The 2010 assessment predicted a continued decline, and suggested that further declines could potentially be linked to a decline in reproductive potential (DFO 2010). At that time the removal of an unknown number of spawners by the commercial fishery was a concern. During 2016, the cod population was at a much lower level of abundance, there were fewer spawners, and the abundance of cod eggs was extremely low (nearly absent) from the water column for the first time in over 19-years of sampling. Furthermore, the Northern cod fishery has increased in both duration and the amount of allowable catch. The ability of Gilbert Bay cod to rebuild towards levels observed at the beginning of the monitoring period is not likely given current management conditions.

In 2010, it was recommended that reference points be created for the Gilbert Bay cod population, consistent with a precautionary approach, to assist management decision making. Reference levels for this population have not been considered. A benchmark, established at some higher level of abundance, possibly based on monitoring CPUE, could assist management decisions.

Only minor modifications to improve inferences based on existing protocols are suggested as part of this review. This includes changes to the indicator of age 0 recruitment, measured at both the egg and the pelagic juvenile stage. Cod egg surveys should continue, and help to determine if there are cod eggs in the water column. The pelagic juvenile survey should continue, but it is necessary to include more detailed species identification. It is important to continue CPUE monitoring of Gilbert Bay cod, both in terms of abundance, size distribution, and relative species abundance.

OTHER CONSIDERATIONS

Management Considerations

The incorporation of additional local and Aboriginal sources of information could help to improve MPA monitoring and management. A continued collaboration with the NunatuKavut Community Council is expected.

Genomic and genetic analysis of Gilbert Bay cod has been included as part of several studies since 1998. A genomic approach towards the conservation of Gilbert Bay cod is a potentially valuable monitoring tool. Genomic analysis can identify cod with 100% accuracy, and could be

used as a means to monitor the proportion of Gilbert Bay cod in the Northern cod fishery. Genomic analysis also supports that the Gilbert Bay cod population is reproductively isolated and contributes to the overall intra-specific diversity of Atlantic Cod.

Cod potting was presented as a potential means to reduce the effect of harvesting upon Gilbert Bay cod. This will depend on the ability of harvesters to identify Gilbert Bay cod when they are caught, and release them alive. Cod potting was tested as part of a pilot project in 2016 with favorable results. If potting was permitted, and if harvesters choose to utilise this fishing methodology rather than gillnets in the vicinity of Gilbert Bay, it could potentially reduce the effect of commercial harvesting on the local cod population.

SOURCES OF INFORMATION

This Science Advisory Report is from the December 8, 2016 Regional Peer Review meeting on Adapting Monitoring Protocols and Strategies for the Gilbert Bay Marine Protected Area. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

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